Mulches for Grass Establishment on Fill Slopes[1]

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ABSTRACT

Eleven mulch treatments were evaluated during the fall of 1966 on a 2:1 northeast-facing fill slope seeded to smooth bromegrass (*Bromus inermis* Leyss.). Mulch materials included wood cellulose fiber, excelsior, jute netting, emulsifiable asphalt used separately and as an anchorage for corncobs, woodchips, prairie hay, and fiberglass. Plots protected with an excelsior mat yielded the best seedling grass.

Eight mulch treatments were evaluated on a 2:1 east-facing fill slope during the fall of 1967. Mulch materials included an emulsifiable polymer, compost, wood cellulose, jute netting, excelsior, and asphalt-anchored mulches of excelsior, woodshavings, and bark dust. Plots protected with an excelsior mat or jute netting yielded the best seedling grass.

Additional index words: **Roadside seeding, Slope stabilization.**

DEEPER cuts, higher fills, and wider rights-of-way on modern roadways have greatly increased erosion problems. Erosion can be kept to a minimum if disturbed areas can be quickly stabilized by a protective vegetative cover. Depending on the season and the cover to be established, this period may vary from one to several months during which time some method of controlling erosion is needed. Although smooth bromegrass (*Bromus inermis* Leyss.), which is a major cool season grass component of roadsides in the North Central Great Plains, will germinate and emerge in 7 to 10 days under ideal conditions, protection is needed until a complete vegetative cover is produced.

Many natural and synthetic materials are being used as mulches to provide protection during initial periods of grass establishment (2, 3). Prairie grass hay is most commonly used for mulching in Nebraska. A tractor-drawn mulch-packer (6) will anchor mulch effectively and economically; however, it cannot be operated properly and safely on slopes much steeper than 4:1. Therefore, a study was undertaken to evaluate certain mulch materials relative to their effects on erosion control and grass establishment on slopes steeper than 4:1. Swanson et al.[3] studied 17 different mulches on 2:1 backslopes of recently constructed farm dams relative to erosion control under simulated rainstorms. These studies were continued to evaluate relatively the same selected mulches on the same regarded sites in terms of their effects on soil temperature, soil water, and grass cover during the critical period of seed germination and seedling establishment.

MATERIALS AND METHODS

On September 6, 1966, 11 selected mulches were applied to field plots approximately 48 km north of Lincoln, Nebraska. Duplicate plots 3 m by 6 m were established in a randomized block design on a northeast-facing 2:1 fill slope. On August 30, 1967, eight mulches were studied in a similar manner approximately 19 km southeast of Lincoln, Nebraska, on a 2:1 east-facing fill slope. A check plot without a mulch was included in each replication at the two sites.

The fill soil on the experimental sites was a silty clay loam. On the basis of a soil test, 45-51-0 kg/ha of N-P-K was applied to the 1966 slope, but only nitrogen at 50 kg/ha was applied to the 1967 slope. The fertilizer was lightly hand raked into the surface of the soil. All plots were seeded with 'Lincoln' smooth bromegrass at the rate of 130 pure live seeds per 10 dm^2. Seeds for each plot were mixed with sand to add supplemental bulk and were applied by hand. Seeding was followed by a very light hand raking. The mulch treatments in Table 1 were then applied at the rates listed. Precipitation during both the 1966 and 1967 test periods was adequate to produce acceptable seedling grass stands.

The mulch treatments were evaluated by their effects on soil temperature, soil water, seedling stand, and dry matter

Table 1. Mulch treatments with description and rates of application on 2:1 fill slopes near Lincoln, Nebraska.

Mulch treatment*	Description and method of application	Rate per hectare† 1966	1967
Asphalt	An emulsifiable asphalt diluted 1:1 with water and spray applied	11. 2 kl	-
Bark dust and asphalt	Cottonwood bark screening smaller than 6. 4 mm applied hydraulically as a slurry and sprayed with 1:1 asphalt emulsion	-	4. 5 MT & 1. 4 kl
Corncobs and asphalt	Hand-spread, ground corncobs slightly larger than 6. 4 mm sprayed with 1:1 asphalt emulsion	11. 2 MT & 1. 4 kl	-
Prairie hay and asphalt	Hand-spread indiangrass sprayed with 1:1 asphalt emulsion	2. 2 MT & 1. 4 kl	-
Fiberglass and asphalt	Continuous filaments of fiberglass applied with compressed air and sprayed with 1:1 asphalt emulsion	1. 1 MT & 1. 4 kl	-
Woodchips and asphalt	Hand-spread elm woodchips from a portable chipper free of leaves and twigs and sprayed with 1:1 asphalt emulsion	13. 4 MT & 1. 4 kl	-
Woodshavings and asphalt	Hand-spread wood shavings cut parallel with grain sprayed with 1:1 asphalt emulsion	-	4. 5 MT & 1. 4 kl
Excelsior and asphalt	Hand-spread 15 cm lengths of wood excelsior sprayed with 1:1 asphalt emulsion	-	2. 2 MT & 1. 4 kl
Excelsior	Hand-spread 15 cm lengths of wood excelsior initially not anchored in place	4. 5 MT	-
Excelsior mat	Hand-applied wood excelsior covered with large mesh, kraft paper netting stapled in place	Mfg. spec.	Mfg. spec.
Excelsior and wood cellulose	Five-centimeter lengths of excelsior hydraulically applied with wood cellulose fiber as a slurry	393 kg & 1. 2 MT	-
Wood cellulose A	Wood cellulose fiber applied hydraulically as a slurry	1. 6 MT	-
Wood cellulose B	Wood cellulose fiber applied hydraulically as a slurry.	1. 6 MT	1. 6 MT
Compost	Composted refuse and sewerage sludge applied hydraulically as a slurry	-	4. 5 MT
Jute net	Hand-applied heavy woven jute net with a 1. 6 by 1. 1 yarn count stapled in place	Mfg. spec.	Mfg. spec.
NC1556L polymer	An emulsifiable polymer diluted 1:46 with water and applied with sprinkling can	-	112 kg
No mulch	Unprotected check plot	-	-

* The mulches were supplied by the following manufacturers: LS-1 asphalt from Chevron Asphalt Co.; Fiberglass from Pittsburgh Plate Glass Co.; Jute-net from Bemis Bros. Bag Co.; Excelsior materials from American Excelsior Corp.; Wood cellulose A from Wood Conversion Co.; Wood cellulose B from Weyerhauser Co.; NC1556L polymer from Dow Chemical Co.; Compost from Metropolitan Waste Conversion Corp.; Bark dust and woodshavings from Suidae Products, Inc. † The undiluted volume of actual material in the case of liquids.

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[3] Swanson, N. P., L. N. Mielke, A. R. Dedrick, and A. E. Dudeck. 1967. Protecting steep fill slopes against water erosion (unpublished data).

production. Soil temperatures were measured during the first week of the studies at the 1.3-cm depth at random within thirds of each plot by means of a three-probe thermistor thermometer. Low temperatures were taken from 5:30 to 6:00 A.M., while high temperatures were taken from 1:30 to 2:00 P.M. Approximately 2 weeks after seeding when the soil surface on the check plots began to crack, soil water in all plots was determined by taking soil cores 5.1 cm in diameter by 1.3 cm deep at two random locations within thirds of each plot. The soil cores were weighed, dried at 105C for 24 hours, and reweighed. Seedling stands and dry matter yields were estimated approximately 2 months after seeding from two random samples in quarters of each plot within a 7.6- × 122-cm quadrat. All grass seedlings within the quadrat were counted and then harvested at ground level, dried for 48 hours at 80C, and then weighed for dry matter yields. All data were evaluated by analysis of variance. Duncan's Multiple Range test (5) was used to place mean values in categories whenever applicable.

RESULTS

Low soil temperatures during the study period for both years ranged from 9 to 17C, while high soil temperatures ranged from 23 to 32C. However, accumulated data of high-low temperatures are not considered to be as meaningful as the daily temperature range. Accordingly, these data were summarized and presented as the mean range of diurnal differences for each treatment from three representative days.

Excelsior and excelsior mat had the greatest influence in moderating soil temperatures (Tables 2 and 3). In 1966, the average of the two treatments was 9 degrees lower in soil temperature range on clear days compared to the unmulched plots (Table 2). The second best group of mulches, which averaged 5 degrees lower than the check plots, included jute net, and asphalt-anchored mulches of prairie hay, corncobs, and woodchips. All other treatments were not significantly different from the check plots. Soil temperatures within plots were consistent and not significantly different throughout the length of the plots.

In the 1967 study, excelsior mat had the greatest influence in moderating soil temperatures, averaging 5 degrees lower than the check plots (Table 3). The second best group of mulches, which averaged 3 degrees lower than the check plots, included jute net and woodshavings anchored with asphalt. Soil temperatures within the plots were consistent.

The mulches studied in 1966 had a singificant influence on soil water, seedling stands, and dry matter yields (Table 4). Plots treated with excelsior mat had the highest soil water content but were not significantly better than plots mulched with excelsior, asphalt, or prairie hay anchored with asphalt. These treatments increase soil water content 75% over that of the check plots. All mulched plots had significantly higher soil water than the unmulched check plots. Plots treated with excelsior mat, excelsior, jute net, and asphalt-anchored mulches of prairie hay or woodchips produced the better grass stands. Two months after seeding, these treatments averaged more than twice as many seedlings as did the check plots. Dry matter yields were highest on plots protected with excelsior mat. These plots yielded five times more dry matter than did the check plots. The second best group of mulches, which averaged three times more dry matter than the check plots, included excelsior, jute net, and asphalt-anchored mulches of prairie hay, woodchips, and fiberglass. While stand counts were not significantly different within plots, significantly less soil water was found in the top one-third of the plots and significantly less dry matter was produced in the top one-quarter to one-half of the plots. Interactions of mulch × location were not significant.

The mulches studied in 1967 also had significant influences on soil water and grass yields (Table 5). Grass stands 2 months after seedling varied from 53 to 77 seedlings per 10 dm² but were not significantly different at the 1% level. At the 5% level, however, jute net and excelsior mat had the best stands when compared to the check plot. Plots mulched with excelsior mat or asphalt-anchored woodshavings had the best soil water, averaging more than twice as much

Table 2. Mean effect of mulch treatments on soil temperature range 1.3 cm below the soil surface on a 2:1 northeast-facing fill slope near Lincoln, Nebraska, in 1966.*

Treatments	Clear day soil temp. range (C)
Excelsior	11.9 a
Excelsior mat	12.7 ab
Jute net	15.7 bc
Prairie hay and asphalt	16.6 cd
Corncobs and asphalt	17.8 cde
Woodchips and asphalt	17.8 cde
Wood cellulose B	19.7 def
Fiberglass and asphalt	20.2 efg
Excelsior and wood cellulose	20.4 efg
No mulch	21.8 fg
Wood cellulose A	22.0 fg
Asphalt	23.6 g

* Means followed by the same letter do not differ significantly at the 5% level.

Table 3. Mean effect of mulch treatments on soil temperature range 1.3 cm below the soil surface on a 2:1 east- facing fill slope near Lincoln, Nebraska, in 1967.*

Treatments	Clear day soil temp. range (C)
Excelsior mat	10.5 a
Jute net	12.2 b
Woodshavings and asphalt	12.2 b
Excelsior and asphalt	13.9 c
Wood cellulose B	14.1 c
Bark dust and asphalt	14.5 cd
Compost	14.5 cd
No mulch	15.0 cd
NC1556L Polymer	15.4 d

* Means followed by the same letter do not differ significantly at the 5% level.

Table 4. Mean effects of mulch treatments on surface-soil water, seedling stands, and grass yields on a 2:1 northeast-facing fill slope near Lincoln, Nebraska, in 1966.*

Treatments	% soil water	Seedlings per 10dm²	Dry matter g/10dm²
Excelsior mat	24.7 a	128.5 a	7.8 a
Excelsior	23.3 ab	101.0 abc	5.2 b
Asphalt	22.4 abc	40.1 e	2.6 cd
Prairie hay and asphalt	22.0 abcd	98.8 abc	4.3 bc
Jute net	20.8 bcde	111.8 ab	5.4 b
Corncobs and asphalt	20.0 cdef	75.8 cd	3.9 bcd
Woodchips and asphalt	19.4 def	96.3 abc	5.3 b
Fiberglass and asphalt	19.0 ef	90.5 bc	4.2 bc
Wood cellulose B	18.4 ef	69.3 cde	3.6 bcd
Wood cellulose A	18.1 ef	70.3 cde	3.2 bcd
Excelsior and wood cellulose	17.7 f	47.8 de	2.4 cd
No mulch	13.2 g	49.1 de	1.5 d

* Means within a column followed by the same letter do not differ significantly at the 5% level.

Table 5. Mean effects of mulch treatments on surface-soil water and grass yields on a 2:1 east-facing fill slope near Lincoln, Nebraska, in 1967.*

Treatments	% soil water	Dry matter g/10dm²
Excelsior mat	14.8 a	9.8 a
Woodshavings and asphalt	13.4 ab	6.9 bcd
Bark dust and asphalt	11.2 bc	6.4 cd
Excelsior and asphalt	10.2 bcd	7.2 bc
Jute net	9.6 cd	8.4 ab
Wood cellulose B	8.4 cd	7.3 bc
NC1556L polymer	7.0 d	6.6 bcd
Compost	6.9 d	5.3 d
No mulch	6.9 d	5.8 cd

* Means within columns followed by the same letter do not differ significantly at the 5% level.

moisture as the unprotected check plots. The second best mulch treatment in comparison to the check plots was the bark dust-asphalt combination. Soil water in plots protected by the other mulches was not significantly better than in the check plots. Grass yields from plots treated with excelsior mat and jute net averaged 57% higher than from the check plots. The remaining mulches performed no better than the unprotected plots. Data on soil temeprature, soil water, seedling stands, and grass yields within the plots were consistent and not significantly different throughout the length of the plots.

DISCUSSION

The higher soil water content in plots protected with excelsior mat, loose excelsior, asphalt, and asphalt anchored mulches of prairie hay and woodshavings was apparently due to the mulches' ability to intercept as well as to retain natural precipitation. The asphalt's influence on soil water was apparently due to its desirable effects on the physical condition of the soil surface. This treatment, however, produced the poorest grass stands. Although the emulsifiable asphalt is specified to be nontoxic to plant material, poor stands were also noted in a 1965 study (1). McKee et al. (3) likewise found the liberal use of asphalt by itself retarded germination and lowered seedling stands. Although the asphalt-anchored woodshavings had good moisture and temperature relations, grass stands and grass yields were poor.

Considerable difficulty was experienced with wind removing the loose excelsior in 1966, and it finally had to be anchored in place with twine and pins. This may account for its poorer performance compared to the excelsior mat.

Normally, favorable grass growth would be associated with high soil water and low soil temperatures. That this relation did not hold for all mulch treatments may be due to the fact that temperature and moisture data were gathered only periodically throughout the test periods. Temperature and moisture relations probably would have been more critical on south- or west-facing slopes than were noted in these studies (3, 4). Consequently, grass yields are the most valid means of differentiating between mulches. In 1966 yields were highest on plots mulched with an excelsior mat, while in 1967 the best mulches were excelsior mat and jute netting.

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